

Nov. 1, 1966

R. J. CHEN ETAL  
DOCUMENT COPYING APPARATUS

3,282,153

Filed May 19, 1964

5 Sheets-Sheet 1

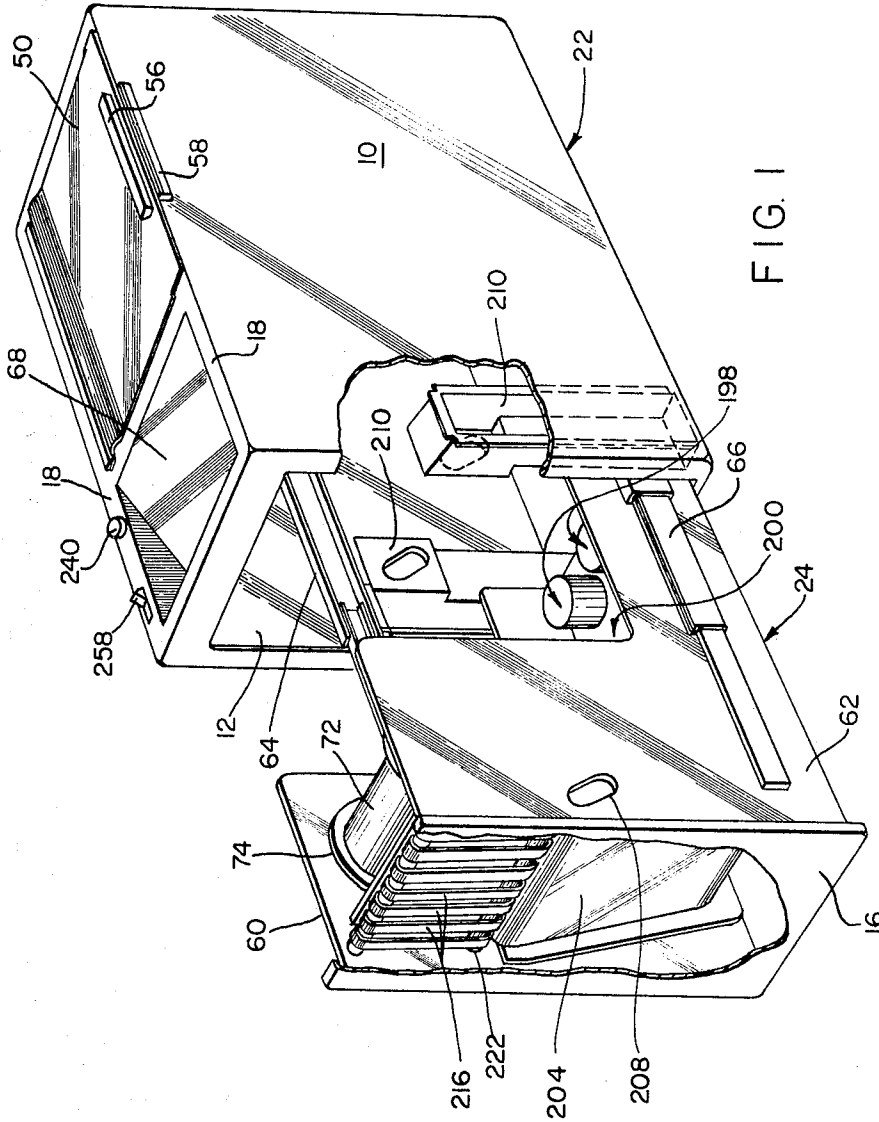


FIG. 1

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5 Sheets-Sheet 2

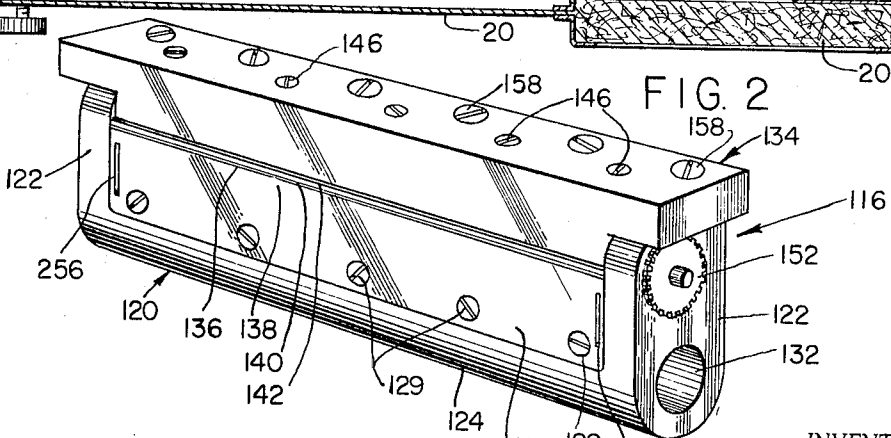
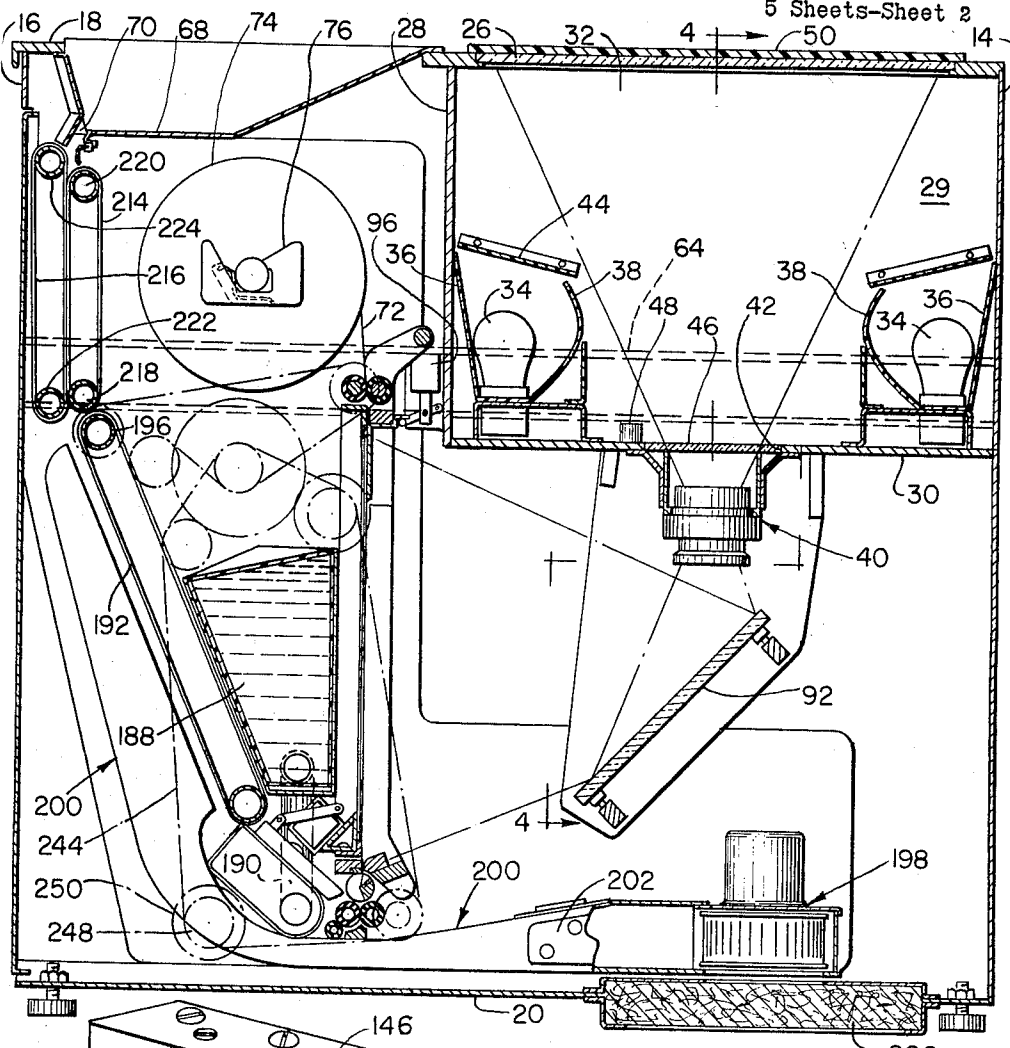


FIG. 5

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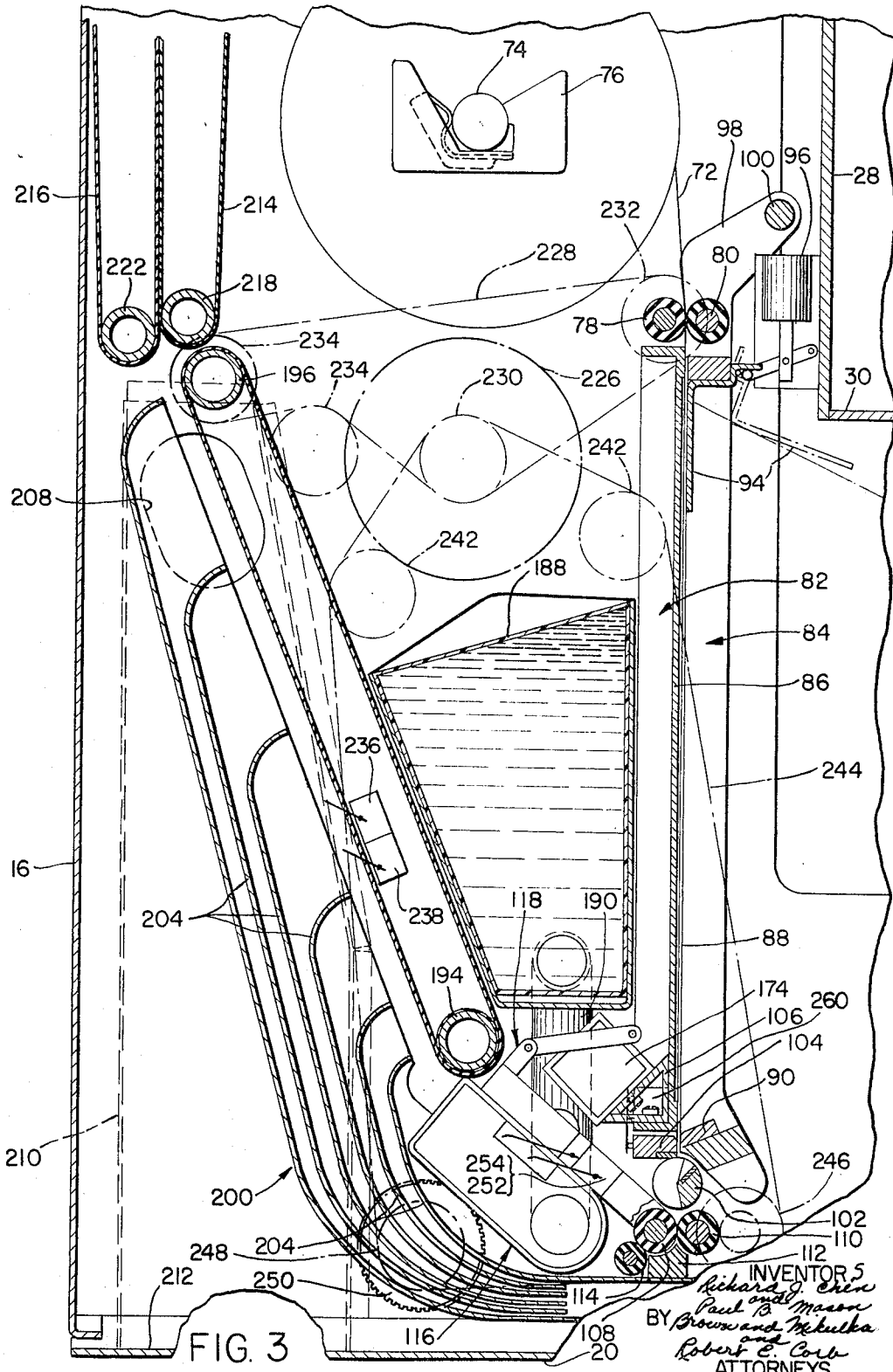
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5 Sheets-Sheet 3



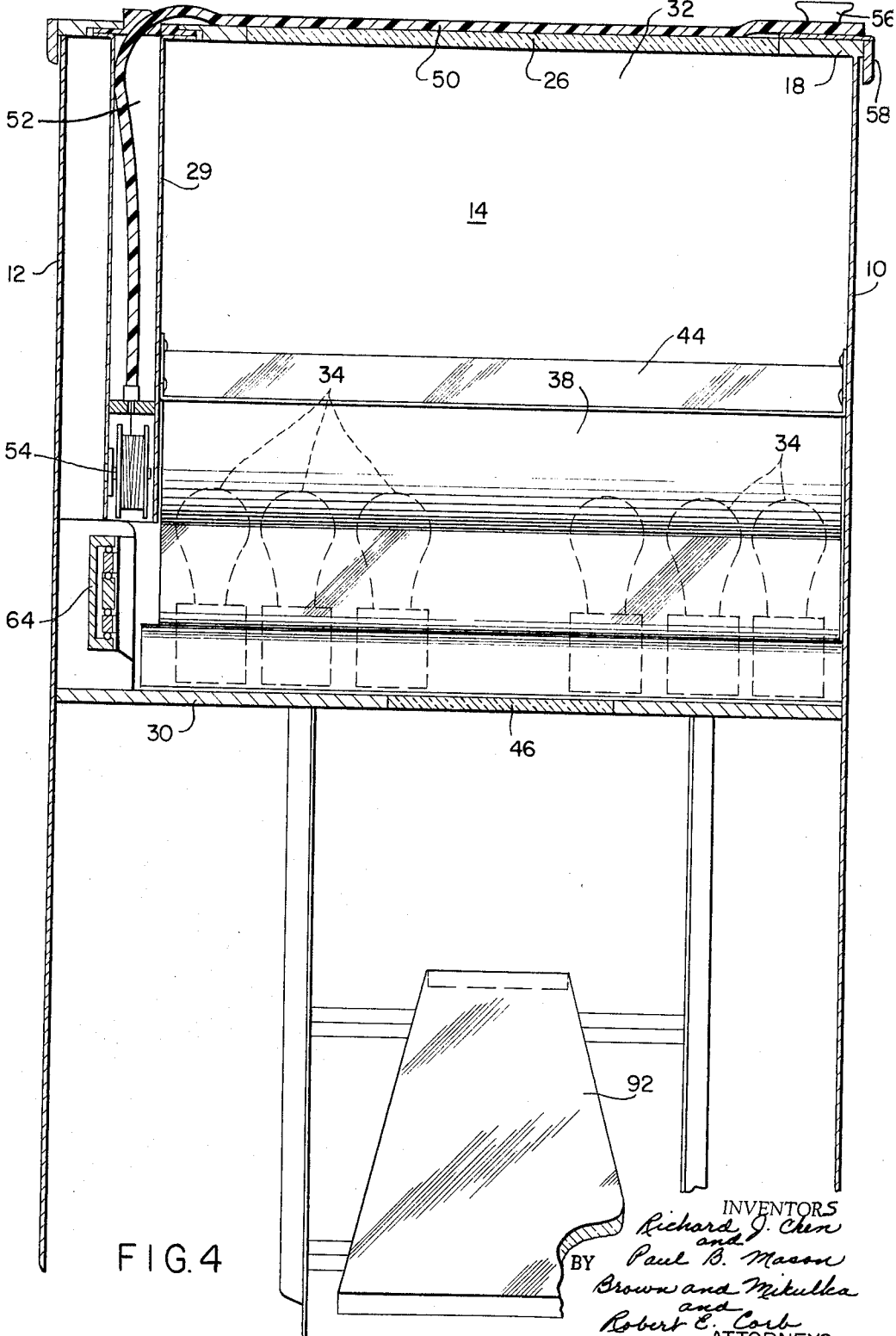
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5 Sheets-Sheet 4



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DOCUMENT COPYING APPARATUS

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5 Sheets-Sheet 5

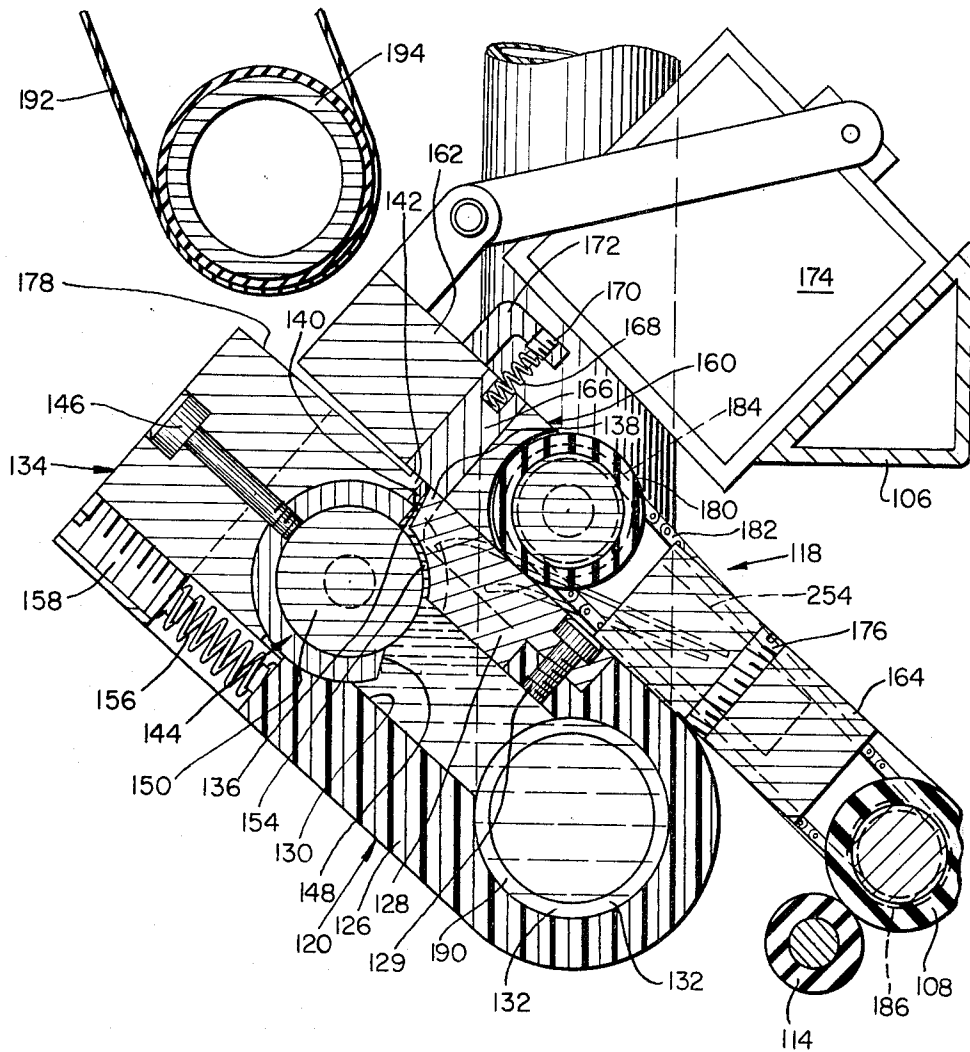


FIG. 6

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3,282,153

**DOCUMENT COPYING APPARATUS**

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 Filed May 19, 1964, Ser. No. 368,620  
 13 Claims. (Cl. 88-24)

This invention relates to photographic apparatus for exposing and processing photographic sheet materials to produce visible images by diffusion transfer, and more particularly, to apparatus for producing copies of documents.

The apparatus of the invention is designed to perform photographic processes and employ photographic products of the type disclosed in the copending U.S. patent applications of Edwin H. Land, Serial No. 368,622 and application Serial No. 368,621, of Edwin H. Land et al., both filed May 19, 1964. The product disclosed in each of the above applications is a single sheet comprising a support and layers including a light-sensitive image-recording material such as a silver halide emulsion, an outer layer containing a translucent material permeable to a liquid processing composition, and a layer for supporting an image, e.g., silver, formed by diffusion transfer of image-forming substances from the layer including the light-sensitive image-recording material. This sheet is subjected to a photographic exposure to form an image in the image-recording material and thereafter, a processing liquid is distributed in contact with the layer containing the translucent material for permeation into the layer containing the light-sensitive image-recording material. The processing liquid reacts with the light-sensitive image-recording material to form an image and an imagewise distribution of image-forming substances which are transferred by diffusion at least through the layer of translucent material to form a visible image which may be viewed as a positive reflection print.

Objects of the invention are: to provide novel and improved photographic apparatus for automatically producing high quality positive photographic prints, particularly copies of documents; and to provide apparatus as described including means for automatically exposing and processing with a liquid, successive sections of a light-sensitive sheet to produce a succession of diffusion transfer prints.

Another object of the invention is to provide photographic apparatus of the character described having an inexpensive compact construction, which is convenient to load and operate, is reliable in its operation and automatically produces copies of different predetermined sizes rapidly and in a finished (dry) condition without material waste.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIGURE 1 is a perspective view of photographic document copying apparatus embodying the invention;

FIG. 2 is a sectional elevational view of the apparatus, the section being taken approximately midway between the sides of the apparatus;

FIG. 3 is an enlarged fragmentary sectional view similar to FIG. 2 showing a portion of the apparatus;

FIG. 4 is a sectional view taken substantially along the line 4-4 of FIG. 2;

FIG. 5 is a perspective view of a component of the apparatus; and

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FIG. 6 is an enlarged sectional view of components including that of FIG. 5 of the apparatus, the section being taken substantially midway between the sides of the components shown.

The invention is incorporated in a substantially automatic document copying apparatus which generally includes means for photoexposing successive areas of predetermined length of a sheet to form an image of a document in each of said areas and thereafter treating each of said exposed areas with a liquid to form a positive transfer image in said area comprising a copy of the original document visible by reflected light. The processing of the exposed sheet involves severance of successive sections of the sheet, each including an exposed area, from the remainder of the sheet, application of a processing liquid to each section of the sheet to form the positive transfer image therein, drying each section and delivering the dried and finished copies (sections) from the apparatus.

The apparatus shown in the drawings is designed to produce copies of two predetermined lengths, specifically eleven inches and fourteen inches, which are substantially one-to-one copies of originals; and to produce the copies substantially automatically requiring only that the operator locate the original to be copied in position for exposure, select the number and size of copies desired and start the apparatus.

Reference is now made to FIGS. 1 through 4 of the drawings wherein the document copier of the invention is shown. The apparatus comprises a housing preferably shaped very much like and about the same size as an ordinary two-drawer file cabinet, and including side walls 10 and 12, end walls 14 and 16, an upper wall 18 and a lower wall 20. The housing is designed to provide a light-tight environment in which the light-sensitive image-recording material is exposed and processed and is formed in two sections including a main housing section 22 comprising side walls 10 and 12, end wall 14 and upper and lower walls 18 and 20. The other section of the housing is in the form of a drawer or carriage including end wall 16 and is mounted for movement with respect to the main housing section to provide access to the interior of the housing to permit loading of expendable materials into the apparatus and/or adjustment and repair of the apparatus.

Exposure of the light-sensitive image-recording material is effected by an exposure system mounted within the main housing section thereon and including a light source for illuminating the subject matter to be photographed, a photographic objective lens for producing an image of the subject matter on the layer containing the image-recording material, means providing a light path between the lens and the image-recording material, and photoelectric exposure control means including a photo-sensitive element and a shutter for insuring an exposure appropriate for the subject matter being photographed. This type of exposure system is preferred because it permits the photography of opaque and three-dimensional subjects and the reproduction of continuous tones. This exposure system includes a transparent window 26 in upper wall 18 of the main housing section near end wall 14 thereof and, underlying the window, a transverse panel 28, side panel 29 and a lower panel 30 cooperating with side wall 10, end wall 14 and upper wall 18 to define a chamber 32 which is light-tight with respect to the remainder of the interior of the housing for containing a light source for illuminating the subject matter, e.g., a document to be copied. The light source comprises, in the form shown, twelve lamps 34 mounted on lower panel 30 and arranged in two rows of six each adjacent opposite ends of chamber 32. The lamps of each row are mounted

within a trough-shaped reflector housing comprising a rear wall 36 located furthest from the center of chamber 32 and a forward wall 38 located between the lamps and the center of chamber 32. The inner surfaces of walls 36 and 38 are preferably highly reflective and the housings perform the functions of more uniformly distributing the light from the lamps while preventing light from the lamps from reaching the objective lens directly. In order to provide uniform exposure, the lamps in each row are arranged in two groups of three spaced toward opposite ends of each row and thereby provide for greater illumination at the margins of window 26 than at the center thereof. This is made necessary because light from portions of the subject at the margins of window 26 is attenuated to a greater extent upon reaching the image-recording layer than is light from portions of the subject nearer the center of window 26.

The exposure system includes a lens and shutter assembly 40 mounted on the underside of lower panel 30 in closing relation to an opening 42 in the lower panel located substantially in at the center window. In order to prevent light from lamps 34 from being specularly reflected from the inner surface of window 26 to the lens of assembly 40, polarizing sheets 44 are mounted in front of the lamps on the reflector housings and a polarizer sheet 46 is mounted in front of the lens in covering relation to opening 42. Sheets 44 are so oriented with respect to sheet 46 that polarized light transmitted by sheets 44 and specularly reflected toward sheet 46 is absorbed by the latter, while light reflected from the subject, being nonpolarized, is transmitted by sheet 46. The shutter of assembly 40 makes an exposure the duration of which is controlled by a system including a photocell 48 mounted within chamber 32 on lower panel 30 adjacent opening 42 in position to measure light from a subject such as a document positioned for exposure against the upper surface of window 26. A photoelectrically controlled shutter suitable for this purpose is shown and described together with its control system in detail in the copending application of David S. Grey, Serial No. 150,228, filed November 6, 1961. This particular shutter is designed to open instantaneously to commence an exposure, measure the light from the subject and, when a predetermined amount of light has passed through the shutter, close to terminate the exposure. In the apparatus of the invention, lamps 34 are turned on simultaneously with the opening of the shutter and are turned off after the shutter closes to terminate the exposure. By virtue of this construction, the exposure of each document, or other subject matter to be photographed, is assured of being proper regardless of the reflection characteristics of the particular document.

The apparatus includes means for retaining documents against the upper surface of window 26 in position for exposure and, in the form shown, these means include a flexible cover 50 formed of a dense material such as a metal-filled organic plastic having sufficient weight to hold in place a document positioned between the cover and window 26. Cover 50 is dimensioned to extend across window 26 and into a well 52 between chamber 32 and side wall 12. Cover 50 is coupled with a return mechanism 54 mounted at the bottom of well 52 so that the cover will return to well 52 following withdrawal of the cover from the well sufficiently to cover a thick object such as a book or the like. Cover 50 is also provided with a handle 56 to facilitate grasping and manipulation of the cover and an angle plate 58 for extending around the corner of upper wall 18 and side wall 10 for retaining cover 50 across window 26.

As previously noted, the apparatus comprises a main housing section 22 and a drawer or carriage 24 which may be withdrawn from the housing to permit loading of expendable materials into the apparatus. Carriage 24 comprises a pair of lateral supporting members 60 and 62 mounted for sliding movement, respectively, on telescoping tracks 64 and 66 mounted on the inner sides of

side walls 12 and 10, respectively. Lateral support members 60 and 62 form the base of carriage 24 and support the components of the apparatus which are mounted on the carriage. Included among these components are means for holding a supply of the sheet material employed in the apparatus, means for positioning successive areas of the sheet for exposure, means for treating the sheet with a liquid and means for drying successive sections of the sheet and delivering the sheets from the apparatus. In this latter regard, upper wall 18 of the main housing section includes a recessed section 68 formed with an opening 70 through which sheets are delivered in an upward direction and deposited upon recessed section 68.

The combined photosensitive and image-receiving sheet employed in the apparatus of the invention is designated 72, and is coiled on a spool 74 including stub shafts at its ends, mounted for rotation in support brackets 76 mounted on lateral support members 60 and 62 underlying recessed section 68 of upper wall 18. From spool 74, sheet 72 is conducted downwardly between a pair of feed rolls 78 and 80 between a pair of guide members 82 and 84. Guide member 82 includes a generally flat plate 86 at least coextensive with the area of sheet 72 to be exposed and having a surface (facing sheet 72) disposed substantially at the focal surface of the lens of assembly 40 and lying in a plane parallel with the axis of the lens and perpendicular to the plane of window 26. Guide member 84 functions to retain successive sections of sheet 72 against plate 86 and comprises a generally rectangular frame including vertical edge sections 88 and a lower horizontal edge member 90 for engaging marginal portions of successive sections of sheet 72 and guiding the sheet between guide members 82 and 84. In the preferred embodiment of the apparatus, successive sections of sheet 72 are exposed substantially to their lateral margins and to the transverse margins, particularly at the lower transverse margin, and accordingly, edge sections 88 and edge member 90 of guide member 84 are formed of a light-transmitting material, organic plastics such as the acrylics being particularly suited to this purpose.

The optical system of the apparatus includes a mirror 92 mounted within main housing section 22 and having a reflecting surface lying in a plane disposed substantially at 45° with respect to the optic axis of the objective lens and the plane of the supporting surface of plate 86, so that light transmitted by the lens of assembly 40 is reflected from mirror 92 at a 90° angle (with respect to the lens axis) toward a section of sheet 72 positioned for exposure between guide members 82 and 84. The mounting of mirror 92 is one which provides for adjustment of the position of the mirror and the mirror itself is in the form of a trapezoid with the edge of the mirror closest the objective lens being substantially shorter than the edge of the mirror furthest from the lens. The apparatus, as previously noted, is designed to produce copies of different sizes, for example, copies of the two standard lengths, specifically, eleven and fourteen inches. Accordingly, the distance between the upper and lower edges of the frame comprising guide member 84 is equal to the maximum length (14") of copies to be made, and provision is made for masking the upper portion of the section of the sheet positioned for exposure when shorter copies are to be made. These means include a shutter plate 94 pivotally mounted on the upper portion of guide member 84 and dimensioned so as to extend downwardly and obscure a predetermined portion of sheet 72 near the upper portion of the frame. Shutter plate 94 is pivotable between the operative position, shown in FIG. 3, in which it extends downwardly so as to obscure a portion (e.g., 3") of sheet 72, to an inoperative position, shown in broken lines in FIG. 3, in which shutter plate 94 is located out of the path of light from the lens of assembly 40. A solenoid 96 coupled with shutter plate 94 by an appropriate linkage is provided for pivoting the

shutter plate between its operative and inoperative positions.

To permit loading of a supply of sheet 72 into the apparatus and threading the sheet between feed rolls 78 and 80 and guide members 82 and 84, feed roll 80 is mounted on extensions 98 of guide member 84 and the latter is mounted for pivotal movement about its lower end on lateral support members 60 and 62. A bar 100 is joined at its ends to extensions 98 and provides a handle for pivoting guide member 84 about its lower end in order to load sheet 72 into the apparatus, and springs (not shown) are provided for biasing guide member 84 into the operative position shown in FIG. 3.

During the operation of the apparatus, a section of sheet 72 is fed downwardly by feed rolls 78 and 80 between guide members 82 and 84 at least until the leading edge of the sheet has passed downwardly beyond edge member 90, whereupon movement of the sheet is arrested with a section of the sheet located in position for exposure. The apparatus includes means for severing successive sections of sheet 72 from the remainder of the sheet so that copies produced by the apparatus are delivered as individual rectangular prints approximately equal in length (11" or 14") to the originals. These means include a rotary knife 102 disposed adjacent and below edge member 90 and adapted to operate against an anvil 104 disposed in juxtaposition with edge member 90. Knife 102 is mounted on lateral support members 60 and 62 for rotation in a counterclockwise direction (viewing FIG. 3) to sever the sheet closely adjacent the lower edge of the section thereof which is exposed. Anvil 104 is mounted on a support bracket 106 which also functions to support the lower portion of guide member 82, and the anvil is movable slightly with respect to bracket 106 for purposes which will be described more fully hereinafter.

A section of sheet 72 positioned between guide members 82 and 84 is exposed following severance at its leading end from the preceding section of sheet 72 and, following exposure, the exposed section is advanced downward by rotation of feed rolls 78 and 80 between knife 102 and anvil 104 into the bite of a second pair of feed rolls 108 and 110 positioned below knife 102. Feed rolls 108 and 110 are rotated to advance the leading edge of sheet 72 against the curved surface of a deflection block 112 mounted beneath the bite of rolls 108 and 110 in position to change the direction of movement of sheet 72 and guide the sheet around the periphery of feed roll 108 between the latter and a third feed roll 114 located in juxtaposition with feed roll 108. The sheet is advanced by feed rolls 108 and 114 upwardly and at an angle into engagement with means for distributing a processing liquid in contact with the exposed side of sheet 72.

The means for distributing a processing liquid in contact with sheet 72 are shown in detail in FIGS. 3, 5 and 6, and include a liquid applicator device designated 116, and a cooperating supporting device 118 located in juxtaposition with one another adjacent opposite sides of the path of movement of sheet 72 from between feed rolls 108 and 114. The processing composition may comprise an aqueous alkaline liquid which is preferably rendered quite viscous by the incorporation of a viscous film-forming material, for example, sodium carboxymethyl cellulose, and the applicator device functions to distribute this viscous liquid as a layer in contact with sheet 72. Applicator device 116 functions to extrude the liquid as a film and simultaneously doctor the film onto sheet 72 to form a thin layer thereon of predetermined thickness. The layer of liquid applied to each section of sheet 72 is substantially rectangular in shape and is preferably coextensive with the section to which it is applied, that is, so that the layer of liquid extends substantially to the four edges of each section of the sheet. Accordingly, the applicator device is constructed to dispense an accurately predetermined amount of liquid and

apply the liquid as a layer having precise dimensions and substantially uniform predetermined thickness to successive rectangular sections of a sheet as each section is moved past and in engagement with the applicator device. The liquid may be highly corrosive (alkaline) and because of the thickening agent, hardens upon drying so that the applicator is specially designed to maintain the liquid in an airtight environment and prevent the liquid from contacting other components of the apparatus.

The applicator device comprises a body section, designated 120, having end walls 122, a longitudinal wall 124, a side wall 126 and a cover plate 128 secured to longitudinal wall 124 by screws 129 (adjacent the side of longitudinal wall 124) opposite side wall 126 to provide an elongated chamber or recess 130 approximately equal in length to the width of sheet 72. One of end walls 122 is formed with an opening 132 communicating with recess 130 providing means for introducing liquid to the recess. Applicator device 116 also includes a closure section 134 mounted on body section 120 and cooperating with the body section and cover plate 128 to provide an elongated passage approximately equal in length to the width of sheet 72 and communicating with recess 130 in the body section. This passage, designated 136, is defined by a tapered edge section 138 of cover plate 128 which abuts against an elastomeric sealing strip 140 secured to an edge section 142 of closure section 134. The applicator device includes means for retaining body section 120 and closure section 134 together, providing for pivotal movement of the body and closure sections with respect to one another to open and close passage 136 and to pump a liquid supplied to recess 130 from the recess through passage 136 so that the liquid is dispensed as a thin layer through the passage. These last-mentioned means comprise a cylindrical tube or sleeve 144 mounted within the applicator device between the body and closure sections and extending lengthwise of the device with the ends of the sleeve engaged in openings (not shown) in end walls 122 of body section 120. Sleeve 144 is secured within a cylindrical channel in closure section 134 to the closure section by screws 146 so that the body section is pivotable with respect to the closure section about the axis of sleeve 144. Sleeve 144 is formed with an axial slot 148 approximately equal in length to recess 130 and passage 136 and communicating with the recess and the passage. Mounted within sleeve 144 is a cylindrical liquid feed roll 150 having an outer diameter which is just sufficiently less than the inner diameter of the sleeve to allow the liquid feed roll to rotate freely within the sleeve. Liquid feed roll 150 extends substantially from end to end of the sleeve and a gear 152 is secured to one end of liquid feed roll 150 for driving the feed roll. A portion of cover plate 128 extends into slot 148 in sleeve 144 and includes a cylindrical surface juxtaposed with the surface of roll 150 and cooperating therewith to define an annular channel 154 communicating between recess 130 and passage 136. In the operation of the applicator device, liquid feed roll 150 is rotated in a counterclockwise direction (viewing FIG. 6) in contact with the viscous liquid filling recess 130, drawing the liquid into channel 154 and functioning as a pump to build up the pressure within the channel for forcing the viscous liquid from channel 154 into and through passage 136 between edge sections 138 and 142. The portion of sleeve 144 defining the longitudinal edge of slot 148 in the sleeve is aligned substantially with the surface of sealing strip 140 which defines one side of passage 136 and functions to conduct the viscous processing liquid from channel 154 into passage 136 while removing the liquid from liquid feed roll 150.

Closure section 134 of the applicator device is mounted in fixed position on carriage 24, and body section 120 of the applicator device is pivoted with respect to closure section 134 about the axis of roll 150 for opening and closing passage 136. Passage 136 is retained in the closed



position shown in FIG. 6 by springs 156 engaged between the body section and adjusting screws 158 threaded into closure section 134. Springs 156 bias body section 120 for rotation in a counterclockwise direction into the closed position shown and the body section is pivoted in a clockwise direction against the bias of springs 156 in order to open passage 136 so that the liquid may be extruded therefrom. Sealing strip 140, being formed of an elastomeric material, cooperates with cover plate 128, which may be formed of metal, to provide a liquid, gas and vapor impervious seal when passage 136 is closed, and adjusting screw 158 provides means for varying the sealing force exerted by spring 156 by adjustably compressing the springs.

Supporting device 118 is provided for holding sheet 72 against cover plate 128 and edge section 142 of closure section 134 as the sheet is moved past passage 136 and for pivoting body section 120 of the applicator device in order to open passage 136. The supporting device comprises a platen 160 pivotally mounted at one end coaxially with feed roll 108 and extending adjacent the applicator device toward the opposite end thereof. Platen 160 includes a section 162 disposed in juxtaposition with cover plate 128 and closure section 134 adjacent opposite sides of passage 136 and supports 164 extending from section 162 toward feed roll 108 and providing means on which section 162 is pivotally mounted for limited movement toward and away from applicator device 116. Section 162 is formed with an elongated opening in which a pressure plate 166 is engaged for movement with respect to the platen toward and away from the applicator device. Pressure plate 166 is at least equal in length to passage 136 and is located in juxtaposition with edge sections 138 and 142 so as to support sheet 72 against the edge sections as the sheet is moved past passage 136. Pressure plate 166 is biased toward the applicator device by a plurality of springs 168 engaged between the pressure plate and adjusting screws 170 threaded into a bracket 172 mounted on section 162.

In the operation of the applicator and supporting device, as a section of sheet 72 is advanced between feed rolls 108 and 114 between section 162 and cover plate 128, platen 160 is pivoted in a counterclockwise direction toward the applicator device so as to pivot the body section of the applicator and press sheet 72 against the applicator. Electrically operated means in the form of a solenoid 174 mounted on bracket 106 are provided for pivoting platen 160, and a pair of set screws 176 are threaded through supports 164 for engaging end walls 122 of body section 120 for pivoting the body section to open passage 136 to a predetermined width. Set screws 176 make it possible to vary the width of opening 136 as well as the gap between platen 160 and cover plate 128 through which sheet 72 is advanced. As the sheet is advanced past opening 136, the liquid is extruded through the opening onto the sheet and edge section 142 functions as a doctor for insuring that the layer of liquid applied to the sheet is of uniform thickness. The surface 178 of closure section 134 facing section 162 of platen 160 is set back from the surface of edge section 142 and relieved so as not to interfere with or disturb the layer of liquid on sheet 72 as the sheet and layer of liquid are moved between section 162 and surface 178. A drive roll 180 is provided pivotally mounted at its ends in a recess in section 162 of platen 160 with the periphery of the drive roll extending from the platen sufficiently to engage sheet 72 located between the platen and cover plate 128. Drive roll 180 includes a surface formed of an elastomeric material having a relatively high coefficient of friction for the purpose of moving sheet 72 between the platen and cover plate 128 across aperture 136 between the latter and pressure plate 166. During coating operations drive roll 180 is rotated by a chain 182 engaged between sprockets 184 and 186 mounted on, respectively, drive roll 180 and feed roll 108.

The processing liquid is supplied to applicator device 116 from a disposable reservoir in the form of a container 188 mounted within the apparatus on the carriage above supporting device 118 behind guide member 82. Container 188 may be formed of any air and water impermeable material, the organic plastics such as polyethylene being especially suited for this purpose, and is connected with the applicator device by a U-shaped conduit 190 coupled with recess 130 at one of end walls 122 by way of opening 132 provided therein, and with the lower portion of container 188 so that the liquid within the container flows through the conduit to the applicator under the force of gravity. Conduit 190 may comprise an expendable component of the container to facilitate replacement of the container of liquid when its liquid contents are exhausted.

The apparatus includes means for withdrawing each successive section of sheet 72 from between the applicator and supporting devices and simultaneously drying the liquid coated sheet rapidly and evenly so that the sheet, comprising a copy of an original, may be delivered from the apparatus in a dry condition. These last-mentioned means are shown in FIGS. 2 and 3 and comprise an endless web 192 supported between two shafts 194 and 196, the former being located closely adjacent the end of section 162 of platen 160 and the latter being mounted on the carriage above shaft 194 and closer to end wall 16, so that the section of web 192 extending between shafts 194 and 196 and facing end wall 16 extends upwardly and at an angle with respect to the vertical as represented by end wall 16. Web 192 may comprise one or more strips of a flexible sheet material preferably having a high coefficient of friction with respect to sheet 72. Shaft 194 is positioned so that the outer surface of web 192, where the web extends around shaft 194, is substantially tangent with the plane of sheet 72 as the sheet emerges from between the applicator and supporting devices. As previously noted, the applicator device is designed to apply a coating of the liquid to sheet 72 substantially to the lateral edges of the sheets and, accordingly, web 192 and the drier of which it is a component are designed to support the web without contacting the liquid-coated surface of the web.

The sheet is supported against web 192 and dried by blowing heated air against the web. For this purpose, the apparatus includes a blower 198, a duct 200 coupled with the blower, a heater 202 mounted within the duct and a plurality of baffles 204 mounted within duct 200. Blower 198, mounted on carriage 24 underlying mirror 92 and duct 200, extends from the blower adjacent lower wall 20 beneath applicator device 116 and then upward adjacent web 192. A filter 206 is provided in an opening in lower wall 20 for removing foreign material from air taken in by the blower. The portion of duct 200 adjacent web 192 is approximately equal in width to the width of sheet 72 and the side of the duct facing the web is open. Baffles 204 extend within duct 200 from a position underlying applicator device 116, include end sections curved toward web 192 and cooperate with each other and the duct to provide a plurality of separate conduits which, by virtue of the curved ends of the baffles, direct the heated air against portions of web 192 succeeding from shaft 194 to shaft 196, thereby supporting sheet 72 against web 192 by air pressure.

In the preferred embodiment of the apparatus shown, the friction between sheet 72 and web 192 is sufficient to withdraw the trailing end portion of each successive section of sheet 72 between edge section 142 of the applicator device and pressure plate 166 of the supporting device. However, it is contemplated that, in some instances, it may be advisable to provide a pair of discs (not shown) in juxtaposition with web 192 at shaft 194 in order to press sheets 72 at their lateral margins (where, usually there is no image) against web 192 and thereby insure

withdrawal of each sheet from between the applicator and supporting devices.

Lateral support members 60 and 62 define the side of duct 200 and are formed with openings 208 adjacent the upper ends of the ducts. The ends of baffles 204 terminate short of web 192 so that air passing through the duct and directed against a sheet supported on the web is conducted along the web toward the end of the duct and exhausted through openings 208. Exhaust ducts 210 are provided on side walls 10 and 12 of the main housing section and extend downwardly from adjacent openings 208 to lower wall 20 which is formed with openings 212 through which the air is exhausted from the housing of the apparatus.

From web 192, a dried copy comprising a section of sheet 72 is conducted upwardly and fed through opening 70 onto recessed section 68 of upper wall 18. For this purpose, a pair of endless webs 214 and 216 are provided, web 214 being supported between a shaft 218 located adjacent shaft 196 and an upper shaft 220 located adjacent opening 70, and web 216 being supported between a lower shaft 222 juxtaposed with shaft 218 and an upper shaft 224 located adjacent opening 70 in juxtaposition with shaft 220. The shafts are so positioned that sections of the webs are in face-to-face relation and the leading end of a section of sheet 72 supported on web 192 moves into the bite of webs 214 and 216 between shafts 218 and 220. Webs 214 and 216 each preferably comprises a plurality of narrow webs positioned in side-by-side relation and formed of flexible material having a high coefficient of friction.

The drive mechanism of the apparatus comprises a motor 226 mounted on carriage 24 between container 188 and spool 74. Motor 226 drives feed roll 78 and shaft 196 through a chain 228 engaged with a sprocket 230 on the motor shaft, a sprocket 232 on roll 78 and a sprocket 234 on shaft 196. The periphery of the portion of web 214 extending around shaft 218 is pressed against the periphery of web 192 at shaft 196 so that torque transmitted to shaft 196 is transferred to web 214 to move webs 214 and 216 so as to advance a sheet 72 upwardly between the webs and through opening 70 onto recess section 68. Feed roll 78 is driven through an electrically operated clutch controlled by a pair of micro switches 236 and 238 mounted between longitudinal sections of web 192 and including control levers extending into the path of movement of sheet 72 supported on web 192. The control levers of switches 236 and 238 are positioned along the path of movement of sheet 72 at predetermined distances, e.g. fourteen and eleven inches respectively, from the edge of anvil 104 at which sheet 72 is severed, and function to deenergize the clutch through which drive roll 78 is driven when a predetermined length, e.g. either eleven or fourteen inches, of sheet 72 has been advanced past anvil 104 and knife 102. Knife 102 is driven through an electrically operated single revolution clutch controlled by either of switches 236 and 238 and, accordingly, functions to sever either a fourteen or eleven inch section of sheet 72 from the remainder of the sheet as the sheet moves between the knife and the anvil. The apparatus includes a control knob 240 extending from upper wall 18 which may be adjusted manually for selecting the number and length of copies to be produced by the apparatus. Control knob 240 also operates solenoid 96 so that the length of sheet 72 which is exposed is substantially equal to the length of the sheet advanced between the knife and the anvil and cut off by the knife.

The drive mechanism also includes idler sprockets 242 for supporting a chain 244 driven by a second sprocket, also designated 230, on the shaft of motor 226. Drive chain 244 is engaged with a drive sprocket 246 mounted on the lower portion of the carriage and coupled through a gear drive with feed roll 110 and the single revolution clutch which drives knife 102. Roll 108 is rotated by roll 110 and, as previously noted, drives drive roll 180

through chain 182 and sprockets coupled with rolls 198 and 180. The drive mechanism includes another drive sprocket 248 coupled with a gear 250 meshed with gear 152 on liquid feed roll 150 for driving the liquid feed roll. In an alternative embodiment of the apparatus, gear 250 may be coupled with sprocket 248 through an electrically operated clutch so that the rotation of feed roll 150 may be controlled separately.

In addition to the controls previously described, the apparatus includes a pair of series connected micro switches 252 and 254 mounted on supports 164 of platen 160 and including control levers extending across the path of movement of sheet 72 between platen 160 and cover plate 128 into recesses 256 in the cover plate. Although the control levers of both micro switches do not actually show in FIG. 6 because the section is taken between the two micro switches which engage the sheet at its margins, the positions of both control levers are shown in FIG. 6 for purposes of illustration. The function of micro switches 252 and 254 is to control the operation of the liquid applicator and supporting devices, particularly the operation of solenoid 174 which moves platen 160 toward and away from the liquid applicator. Both micro switches are in series in a circuit with the solenoid and are normally open so that only when both control levers are engaged by a sheet are the micro switches closed energizing solenoid 174 and causing platen 160 to be moved toward applicator device 116. When this occurs, set screws 176 engage end walls 122 of the applicator device pivoting body section 120 of the applicator device and opening passage 136 to permit the liquid to flow therefrom. Solenoid 174 remains energized until one of the micro switches opens and this occurs when the control lever of switch 254, which first engages the leading edge of the sheet, drops off the sheet at the trailing edge thereof. The purpose of the particular arrangement of the control levers is to commence application of the liquid as close as possible to the leading edge of a sheet and terminate application of the liquid as close as possible to the trailing edge of the sheet. Accordingly, the control lever of switch 252 is positioned as close as possible to passage 136 and commences the application of the liquid while the control lever of switch 254 is located furthest from passage 136 and terminates the application of the liquid. When solenoid 174 is deenergized allowing platen 160 to move away from the applicator device, there is a slight overrun of the processing liquid and, accordingly, the distance between the control lever of switch 254 and passage 136 is adjusted to insure that the layer of liquid applied to the sheet will terminate as close as possible to the trailing edge of the sheet. In the embodiment of the apparatus shown, liquid feed roll 150 may rotate to pump the liquid into passage 136 throughout the period during which motor 226 is running. However, the problems involved in sealing passage 136 against the flow of liquid are reduced if liquid feed roll 150 is rotated only during the period when the passage is open, and this may be accomplished by controlling the aforementioned electrically operated clutch using micro switches 252 and 254 for this purpose.

To operate the apparatus, the operator turns knob 240 to select the length and number of copies to be produced, and then lifts cover 50 and places the original on window 26 with an edge of the original located in alignment with a visible reference on the exterior of the window. The operator then closes a switch designated 258 projecting above upper wall 18 near knob 240 to start the apparatus, the switch functioning to start motor 226, blower 198 and heater 202, energize the lamps and render the exposure control system operative to make an exposure. Solenoid 96 is energized to pivot shutter plate 94 out of the path of light from the lens of assembly 40, if the shorter, e.g., 11", of the two possible copies is to be made. The shutter of assembly 40 opens and remains open for a predetermined period

dependent upon the light reaching photocell 48 from the original being copied and then closes and, upon closing, completes circuits through relays to the clutch which drives roll 78 and the single revolution clutch which drives knife 102. The power supply to the shutter is then interrupted so that the exposure cannot be repeated until another section of sheet 72 is in position for exposure. When the clutch driving roll 78 is energized, the roll rotates advancing the exposed section of sheet 72 downwardly between the knife and anvil between rolls 110 and 108, against deflector block 112 and thence upwardly between rolls 108 and 114 between applicator device 116 and supporting device 118 into engagement with web 192. When one of switches 236 and 238 is actuated, the clutch driving roll 78 is deenergized and the single revolution clutch driving rotary knife 102 is energized thereby simultaneously discontinuing the movement of sheet 72 and cutting off the exposed section of the sheet. Anvil 104 is coupled with a switch 260 so that, when knife 102 cuts sheet 72 against the anvil, switch 260 is actuated to connect the power supply to the exposure system so that another exposure can be made.

The components of the control system have not been shown and described in detail inasmuch as they include conventional devices such as relays and switches, and their specific selection and arrangement are considered to be well within the skill of the art when the function of the control system as described is known. For example, switches 236, 238 and 260 are closed when actuated to operate relays which control the flow of current to the clutches which drive roll 78 and rotary knife 102 and to the exposure control system. Platen 160 is biased apart from the applicator device so that switches 252 and 254 are normally open and are in series with the power supply to solenoid 174. The control circuit also includes a counter for recycling the apparatus if more than one copy is to be made and also controls the operation of solenoid 96 depending on the size of copies selected. When the number of copies desired has been made, the operator opens switch 258 interrupting the power to motor 226, blower 198, heater 202 and the exposure system including lamps 34, shutter 40 and the exposure control system associated therewith. In an alternative embodiment of the exposure control system, lamps 34 may be operated in conjunction with the shutter, and, in this system, are energized when the shutter opens and deenergized when the shutter closes.

To load a supply of sheet 72 into the apparatus, carriage 24 is withdrawn substantially to the position shown in FIGURE 1, guide member 84 is pivoted in a clockwise direction to separate roll 80 from roll 78, a spool of sheet 72 is mounted at its ends in support bracket 76 and the leading end of the sheet is fed between rolls 78 and 80, and guide member 84 is pivoted back to engage the sheet between rolls 78 and 80. The controls described heretofore may include a loading control which permits the operator to operate motor 226 and energize the clutch drive roll 78 in order to feed the leading end of sheet 72 downwardly to a position adjacent anvil 104. The carriage is then moved into the main housing section and the apparatus is run through a couple of cycles of operation to pass the leading end portion of sheet 72 through the machine and thereby bring an unexposed section of the sheet into position for exposure. It is contemplated that a length of sheet 72 will be provided on spool 74 sufficient to make a large number of copies, for example, a thousand, and that simultaneously with the loading of spool 74 into the apparatus, a container 188 holding sufficient liquid to process the thousand copies will also be loaded into the apparatus. Obviously, loading of the apparatus is a very simple matter requiring no mixing of liquids and the simple loading of a single sheet. The operation of the apparatus is even more simple, requiring only that the operator place an original in position for exposure, select the number and size copies to

be made and press a button to start the apparatus. The apparatus automatically delivers the desired number of copies of the proper size in a dry condition and all of these functions are performed by devices housed in apparatus which is relatively small and compact.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In photographic apparatus including support means for locating successive sections of a photosensitive sheet in position for exposure, exposure means for exposing said successive sections and means for moving successive sections of said sheet into and from engagement with said support means, in combination, means for processing said sections of said photosensitive sheet comprising:

cutting means located adjacent said support means and the leading edge of a section of said sheet located in position for exposure by said support means, for severing said section of said sheet from the remainder of said sheet following exposure and movement of said section from engagement with said support means;

applicator means adjacent said cutting means for applying a processing liquid to each of said sections during movement of said each section relative to and in engagement with said applicator means;

first advancement means located in the path of movement of said each section between said cutting means and said applicator means for moving said each section relative to and into engagement with said applicator means;

second advancement means located to the side of said applicator means opposite said cutting means for engaging said each section of said sheet to move said each section relative to and from engagement with said applicator means and along a path through said apparatus; and

control means including a sheet sensing element mounted in said path of movement of said each section of said sheet at a predetermined distance along said path from said cutting means and responsive to engagement by the leading edge of said each section for actuating said cutting means to sever said each section from the next succeeding section of said sheet and deactivating said means for moving said sections of said sheet into and from engagement with said support means, with said next succeeding section of said sheet located by said support means in position for exposure.

2. Photographic apparatus as defined in claim 1 wherein said control means include two of said sensing elements positioned at different predetermined distances along said path of said section and means for causing a selected one of said sensing elements to operate said control means to deactivate said first advancement means and actuate said cutting means when said leading edge of said section engages said one sensing element.

3. Photographic apparatus as defined in claim 2 including means for obscuring and preventing exposure of the trailing end portion of said section positioned for exposure by said support means when said sensing element closest said cutting means is operative to deactivate said first advancement means.

4. Photographic apparatus as defined in claim 3 wherein said means for obscuring said section is constructed to prevent exposure of a length of said section approximately equal to the distance along said path between said sensing elements.

5. Photographic apparatus for exposing and processing, with a liquid, successive sections of a light-sensitive

sheet to produce a succession of diffusion transfer prints, said apparatus, comprising, in combination:

- a housing for mounting and enclosing components of said apparatus;
- means for locating a subject in position for exposure on the exterior of said housing;
- means within said apparatus for holding a supply of an elongated light-sensitive sheet including a multiplicity of sections each adapted to be exposed and processed with a liquid to produce a photograph of a subject;
- supporting means for engaging and locating said successive sections of said sheet in position for exposure;
- first advancement means for moving said sections in succession from said supply into and from engagement with said support means;
- exposure means for illuminating a subject positioned for exposure on the exterior of said housing and forming an image thereof on one side of said section of said light-sensitive sheet engaged and located by said support means in position for exposure;
- cutting means located adjacent the leading edge of said one section positioned for exposure for severing said one section of said sheet from the remainder of said sheet following exposure and movement of said one section from engagement with said support means;
- applicator means for applying a processing liquid to said one side of each of said sections during movement of said each section relative to and in engagement with said applicator means;
- second advancement means located in the path of movement of said each section between said cutting means and said applicator means for moving said each section relative to and into engagement with said applicator means;
- means for drying said sheet during movement relative thereto;
- third advancement means for engaging the other side of said each section of said sheet to support and move said each section relative to said means for drying said each section;
- fourth advancement means for engaging said each section at said third advancement means and delivering said each section from said apparatus; and
- control means including a sensing element mounted in the path of movement of said section of said sheet at a predetermined distance along said path from said cutting means and responsive to engagement by the leading edge of said section for actuating said cutting means to sever said section from the next succeeding section of said sheet and deactivating said first advancement means with said next succeeding section of said sheet in position for exposure.

6. The photographic apparatus of claim 5 in which said control means include two of said sensing elements positioned at different predetermined distances along said path of said section and means for causing a selected one of said sensing elements to operate said control means to deactivate said first advancement means and actuate said cutting means when said leading edge of said section engages said one sensing element.

7. The photographic apparatus of claim 6 including means for obscuring and preventing exposure of the trailing end portion of said section positioned for exposure when said sensing element closest said cutting means is operative to deactivate said first advancement means.

8. The photographic apparatus of claim 7 in which said means for obscuring said section is constructed to prevent exposure of a length of said section approximately equal to the distance along said path between said sensing elements.

9. Photographic document copying apparatus comprising, in combination:

- a housing including first and second sections mounting and enclosing the components of said apparatus, said second housing section including a carriage mounted within said first housing section and withdrawable therefrom to provide access to the interior of said housing;
- exposure means associated with said first housing section and including means for locating a document in position for exposure on the exterior of said first housing section, means within said first housing section for illuminating said document, means including an optical system for forming an image of said document at a plane within said housing, and means for controlling the duration of each exposure made by said exposure means;
- means mounted on said carriage for holding a supply of an elongated light-sensitive sheet including a multiplicity of portions, each adapted to be exposed and processed by a liquid to produce a copy of a document;
- supporting means mounted on said carriage for engaging and guiding a succession of said portions of said sheet into position for exposure substantially in said plane;
- first advancement means mounted on said carriage adjacent said support means for moving a succession of said portions of said sheet from said supply into and from engagement with said support means;
- cutting means mounted on said carriage adjacent the leading edge of one of said portions of said sheet positioned for exposure, for severing said one portion from the remainder of said sheet following exposure and movement of said one portion from engagement with said support means;
- applicator means mounted on said carriage for applying a processing liquid to one side of said each portion of said sheet during movement of said each portion relative to and in engagement with said applicator means;
- a sheet transport system mounted on said carriage and including second advancement means located in the path of movement of said each portion of said sheet between said cutting means and said applicator means for moving said each portion relative to and in engagement with said applicator means, and third advancement means for moving said each portion of said sheet from said applicator means through and from said apparatus; and
- means including a sheet sensing element mounted in the path of movement of said portion of said sheet at a predetermined distance along said path of movement of said portion from said cutting means and responsive to engagement by the leading edge of said portion for actuating said cutting means to sever said portion from the next succeeding portion of said sheet and deactivating said first advancement means with said next succeeding portion of said sheet in position for exposure.

10. The photographic apparatus of claim 9 in which said control means include two of said sensing elements positioned at different predetermined distances from said cutting means along said path and means for causing a selected one of said sensing elements to operate said control means to deactivate said first advancing means and actuate said cutting means when said leading edge of said portion engages said one sensing element.

11. The photographic apparatus of claim 10 including means for obscuring and preventing exposure of the trailing end section of said portion of said sheet positioned for exposure when said sensing element closest said cutting means is operative to deactivate said first advancement means.

12. The photographic apparatus of claim 11 in which said means for obscuring said trailing end section of said

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portion is constructed to prevent exposure of said section approximately equal in length to the distance along said path between said sensing elements.

13. Photographic document copying apparatus, comprising, in combination:

a housing including first and second sections mounting and enclosing the components of said apparatus, said second housing section including a carriage mounted within said first housing section and withdrawable therefrom to provide access to the interior of said housing;

exposure means associated with said first housing section and including means for locating a document in position for exposure on the exterior of said first housing section, means within said first housing section for illuminating said document, means including an optical system for forming an image of said document at a plane within said housing, and means for controlling the duration of each exposure made by said exposure means;

means mounted on said carriage for holding a supply of an elongated light-sensitive sheet including a multiplicity of portions, each adapted to be exposed and processed by a liquid to produce a copy of a document;

supporting means mounted on said carriage for engaging and guiding a succession of said portions of said sheet into position for exposure substantially in said plane, said supporting means comprising a pair of juxtaposed members for engaging said portions of said sheets between said members and one of said members being mounted for movement with respect to the other of said members to spread said members for threading of said sheets therebetween;

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first advancement means including a pair of juxtaposed rolls, one of which is mounted on said member for movement therewith apart from the other of said rolls, for moving a succession of said portions of said sheet from said supply into and from engagement with said support means;

cutting means mounted on said carriage adjacent the leading edge of one of said portions of said sheet positioned for exposure, for severing said one portion from the remainder of said sheet following exposure and movement of said one portion from engagement with said support means;

applicator means mounted on said carriage for applying a processing liquid to one side of said each portion of said sheet during movement of said each portion relative to and in engagement with said applicator means; and

a sheet transport system mounted on said carriage and including second advancement means located in the path of movement of said each portion of said sheet between said cutting means and said applicator means for moving said each portion relative to and in engagement with said applicator means, and third advancement means for moving said each portion of said sheet from said applicator means through and from said apparatus.

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